

REMARKS

In the last Office Action, the Examiner objected to the drawings under 37 C.F.R. §1.83(a) as failing to show features recited in claims 6, 16, 17 and 27. The drawings were further objected to as failing to comply with 37 C.F.R. §1.84(p)(5) because Fig. 2 does not show reference sign R1 described on page 13 of the specification. Claim 9 was rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement. Claims 12-14 and 37 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,675,532 to Gemma et al. ("Gemma"). Claims 1, 5-7, 10, 11, 20-22, 24, 25, 33-36, 41, 42 and 45-48 were rejected under 35 U.S.C. §102(b) as being anticipated by European Patent No. 964,251 to Sato et al. ("Sato"). Claim 8 was rejected under 35 U.S.C. §103(a) as being unpatentable over Sato in view of U.S. Patent No. 6,335,522 to Shimada et al. ("Shimada"). Claim 38 was rejected under 35 U.S.C. §103(a) as being unpatentable over Gemma in view of Shimada. Claims 12 and 15 were rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,354,985 to Quate ("Quate '985") in view of Gemma. Claims 12, 16 and 18 were rejected under 35 U.S.C. §103(a) as being unpatentable over Shimada in view of Gemma. Claims 17 and 29-32 were allowed by the Examiner. Claims 19, 23, 39,

40, 43 and 44 were objected to as being dependent upon a rejected base claim, but indicated to be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Applicants and applicants' counsel note with appreciation the indication of allowable subject matter concerning claims 17, 19, 23, 29-32, 39, 40, 43 and 44. However, for the reasons noted below, applicants respectfully submit that claims 1, 5-16, 18, 20-22, 24, 25, 33-38, 41, 42 and 45-48 also patentably distinguish from the prior art of record.

In accordance with the present response, claim 9 has been amended to overcome the rejection under 35 U.S.C. §112, first paragraph. More specifically, claim 9 has been amended to change "gradient-index lens" to "refractive-index lens". Support for the "refractive-index lens" is found on page 19, lines 5-10 of the specification.

In view of the foregoing, applicants respectfully submit that the rejection of claim 9 under 35 U.S.C. §112, first paragraph, has been overcome and should be withdrawn.

With respect to the drawing objections, proposed drawing revisions addressing the objections were submitted in the supplemental response filed August 7, 2003. More specifically, a proposed drawing revision was submitted in

Fig. 2 to show the reference sign R1 described on page 13 of the specification. A proposed new Fig. 27 was submitted to shows the embodiment of the probe 1 having a plurality of surfaces 1a, 1b with different taper angles, as recited in claim 6. The specification was suitably revised to conform the written description to the drawing revisions.

In view of the foregoing, applicants respectfully submit that the objection to the drawings under 37 C.F.R. §1.83(a) as failing to show the feature recited in claim 6 and the objection to the drawings as failing to comply with 37 C.F.R. §1.84(p)(5) have been overcome and should be withdrawn.

The amendment to claim 9 made herein does not raise new issues requiring further search and/or consideration. Instead, claim 9 has been amended to overcome the rejection under 35 U.S.C. §112, first paragraph, by changing "gradient-index lens" to "refractive-index lens" which is supported by the disclosure on page 19, lines 5-10 of the specification, thereby placing the application in condition for allowance or otherwise materially reducing the issues which remain for appeal.

Applicants respectfully request reconsideration of their application in light of the following discussion.

Brief Summary of the Invention

The present invention is directed to a near-field optical probe having a cantilever and a probe formed of a transparent material, a method for manufacturing the near-field optical probe, and an optical apparatus having the near-field optical probe.

As described in the specification (pgs. 1-3), conventional scanning near-field optical probes have been associated with problems which affect observation and measurement of accurate information from the surface of a sample. For example, the intensity of near-field light illuminated from a microscopic aperture of the conventional scanning near-field optical probes has not been able to be effectively increased. Furthermore, in the conventional SNOM probe shown in Fig. 17, since a structural part of the SNOM is disposed in an optical path of the microscope, the intensity of incident light or detection light attenuates due to reflection upon the structural part.

The present invention overcomes the drawbacks of the conventional art. Figs. 1-2 show an embodiment of a near-field optical probe 1000 according to the present invention embodied in the claims. The near-field optical probe 1000 has a cantilever 2 formed of a transparent material and having a first main surface and a second main surface opposite the

first main surface. A base 3 supports the cantilever 2 at the first main surface. A tip 1 extends from the second main surface of the cantilever 2 and has a microscopic aperture 5 at an end thereof. According to the present invention, the tip 1 is formed of a transparent material having a higher refractive index than that of the transparent material of the cantilever 2 in order to increase an amount of near-field light generated or detected by the microscopic aperture. A shade film 5 is formed on the second main surface of the cantilever 2 and on a surface of the tip 1 except for the microscopic aperture 5.

By the foregoing construction, the cantilever and the tip are formed of transparent materials having different optical characteristics. More specifically, by providing a tip formed of a transparent material having a higher refractive index than that of the transparent material of the cantilever, an amount of near-field light generated or detected by the microscopic aperture is increased as compared to the conventional art. Furthermore, the intensity of the near-field light generated or detected by the microscopic aperture is enhanced due to the higher refractive index of the tip transparent material.

Traversal of Prior Art R j ctions

Rejections Under 35 U.S.C. §102

Claims 12-14 and 37 were rejected under 35 U.S.C. §102(b) as being anticipated by Gemma. Applicants respectfully traverse this rejection and submit that claims 12-14 and 37 recite subject matter which is not identically disclosed or described in Gemma.

Independent claim 12 is directed to a near-field optical probe and requires a cantilever having a first main surface and a second main surface opposite the first main surface, the cantilever being disposed at an inclination angle θ_1 relative to a surface of a sample, a base supporting the cantilever at the first main surface, a tip having a height H and extending from the second main surface of the cantilever and having a microscopic aperture at an end thereof, and a shade film formed on the second main surface of the cantilever and on a surface of the tip except for the microscopic aperture. Claim 12 further requires that when a radius of a light spot on the cantilever resulting from light incident on the tip or light detected by the microscopic aperture and being incident on a detector is R_1 , a distance L_1 from a center of the tip to a free end of the cantilever satisfies the equation $R_1 < L_1 < H / \tan \theta_1$. No corresponding structural

combination is disclosed or suggested by the prior art of record.

Gemma discloses a near-field optical probe having a cantilever main body 40 made of an optical fiber whose end portion is bent in to an L shape to form a tip having an aperture (Figs. 7-8). An electrode 41 covers the entire outer surface of the cantilever main body 40. Light is emitted from a semiconductor laser 106 onto the surface of the cantilever main body 40. Light reflected by the cantilever is detected by a photodiode 107. However, Gemma does not disclose or describe the condition met by the structural combination of the near-field optical probe recited in independent claim 12. More specifically, Gemma does not disclose or describe that when a radius of a light spot on the cantilever resulting from light incident on the tip or light detected by the microscopic aperture and being incident on a detector is R_1 , a distance L_1 from a center of the tip to a free end of the cantilever satisfies the equation $R_1 < L_1 < H/\tan \theta_1$.

The Examiner contends that in Gemma the value R_1 is the size of the aperture at the tip of the cantilever body 40 because R_1 can be the radius of light detected by the aperture. The Examiner further contends that since Figs. 7-8 of Gemma show that R_1 is much less than L_1 (i.e., the distance from a center of the tip to a free end of the cantilever),

Gemma discloses the condition $R1 < L1 < H / \tan \theta 1$ recited in independent claim 12. Applicants respectfully disagree with the Examiner's contention.

First, contrary to the Examiner's contention, claim 12 requires that the value R1 is the radius of a light spot on the cantilever resulting from light incident on the tip or light detected by the microscopic aperture and being incident on the detector. As recognized by the Examiner, Gemma does not disclose or describe the specific value R1 for the radius of a light spot on the cantilever in the condition $R1 < L1 < H / \tan \theta 1$ recited in claim 12. It is not understood what the Examiner's rationale is for concluding that R1 in Gemma is the radius of the aperture simply because R1 in claim 12 can be the radius of a light spot on the cantilever resulting from light detected by the microscopic aperture. There is simply no disclosure in Gemma for the Examiner's foregoing correlation between the radius of the aperture and the radius of a light spot on the cantilever resulting from light detected by the microscopic aperture (i.e., that in Gemma the radius of the aperture is equal to the radius of a light spot on the cantilever resulting from light detected by the microscopic aperture).

Second, as shown in Fig. 7 of Gemma, a radius R1 of a light spot on the cantilever body 40 resulting from light

incident on the tip or light detected by the aperture is greater than a distance L_1 from a center of the tip to a free end of the cantilever body. Accordingly, the near-field optical probe disclosed by Gemma does not satisfy the condition $R_1 < L_1 < H/\tan \theta_1$ required by independent claim 12.

Moreover, since R_1 is greater than L_1 in Gemma as set forth above, the area of the surface of the cantilever body 40 is smaller than the diameter of incident light. As a result, the cantilever body 40 exposes the sample 20 to the incident light which results in the deterioration of optical detection. In contrast, independent claim 12 requires that when a radius of a light spot on the cantilever resulting from light incident on the tip or light detected by the microscopic aperture and being incident on a detector is R_1 , a distance L_1 from a center of the tip to a free end of the cantilever satisfies the equation $R_1 < L_1 < H/\tan \theta_1$. Thus since in claim 12 R_1 is less than L_1 , the sample will not be exposed to the incident light.

In the absence of the foregoing disclosure recited in independent claim 12, anticipation cannot be found. See, e.g., W.L. Gore & Associates v. Garlock, Inc., 220 USPQ 303, 313 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984) ("Anticipation requires the disclosure in a single prior art reference of each element of the claim under consideration");

Continental Can Co. USA v. Monsanto Co., 20 USPQ2d 1746, 1748 (Fed. Cir. 1991) ("When more than one reference is required to establish unpatentability of the claimed invention anticipation under § 102 can not be found."); Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co., 221 USPQ 481, 485 (Fed. Cir. 1984) (emphasis added) ("Anticipation requires the presence in a single prior art reference disclosure of each and every element of the claimed invention, arranged as in the claim").

Stated otherwise, there must be no difference between the claimed invention and the reference disclosure, as viewed by a person of ordinary skill in the field of the invention. This standard is clearly not satisfied by Gemma for the reasons stated above. Furthermore, Gemma does not suggest the claimed subject matter and, therefore, would not have motivated one skilled in the art to modify Gemma's near-field optical probe to arrive at the claimed invention.

Claims 13, 14 and 37 depend on and contain all of the limitations of independent claim 12 and, therefore, distinguish from the reference at least in the same manner as claim 12.

In view of the foregoing, applicants respectfully request that the rejection of claims 12-14 and 37 under 35 U.S.C. §102(b) as being anticipated by Gemma be withdrawn.

Claims 1, 5-7, 10, 11, 20-22, 24, 25, 33-36, 41, 42 and 45-48 were rejected under 35 U.S.C. §102(b) as being anticipated by Sato. Applicants respectfully traverse this rejection and submit that claims 1, 5-7, 10, 11, 20-22, 24, 25, 33-36, 41, 42 and 45-48 recite subject matter which is not identically disclosed or described in Sato.

Independent claim 1 is directed to a near-field optical probe and requires a cantilever formed of a transparent material and having a first main surface and a second main surface opposite the first main surface, a base supporting the cantilever at the first main surface, and a tip extending from the second main surface of the cantilever and having a microscopic aperture at an end thereof, the tip being formed of a transparent material having a higher refractive index than that of the transparent material of the cantilever to increase an amount of near-field light generated or detected by the microscopic aperture. Claim 1 further requires a shade film formed on the second main surface of the cantilever and on a surface of the tip except for the microscopic aperture. No corresponding structural combination is disclosed or described by Sato.

Sato discloses an optical waveguide probe comprised of an optical waveguide 1 having a fixed portion 3 and a resilient function portion 4 both made of a core 8 and a

cladding 9 (Fig. 2). The resilient function portion 4 continues to a probe needle portion 5. Thus the fixed portion 3, the resilient function portion 4 and the needle portion 5 have the same structure and are made of the same material having the same optical characteristics. In contrast, independent claim 1 requires a near-field optical probe having a tip formed of a transparent material having a higher refractive index than that of the transparent material of the cantilever to increase an amount of near-field light generated or detected by the microscopic aperture. Stated otherwise, unlike the optical waveguide 1 of Sato, the tip and the cantilever of the near-field optical probe recited in claim 1 have different optical characteristics. In the absence of the foregoing disclosure recited in independent claim 1, anticipation cannot be found. Furthermore, Sato does not suggest the claimed subject matter and, therefore, would not have motivated one skilled in the art to modify Sato's optical waveguide probe to arrive at the claimed invention.

Claims 5-7, 10, 11, 20-22, 24, 25, 33-36, 41, 42 and 45-48 depend on and contain all of the limitations of independent claim 1 and, therefore, distinguish from the reference at least in the same manner as claim 1.

In view of the foregoing, applicants respectfully request that the rejection of claims 1, 5-7, 10, 11, 20-22, 24, 25, 33-36, 41, 42 and 45-48 under 35 U.S.C. §102(b) as being anticipated by Sato be withdrawn.

Rejections Under 35 U.S.C. §103(a)

Claim 8 was rejected under 35 U.S.C. §103(a) as being unpatentable over Shimada. Applicants respectfully traverse this rejection and submit that the teachings of the reference do not disclose or suggest the subject matter recited in claim 8.

Claim 8 depends on and contains all of the limitations of independent claim 1 and, therefore, distinguishes from the reference at least in the same manner as claim 1.

Furthermore, Shimada discloses a near-field optical probe having a tip and a cantilever formed of a transparent material. However, Shimada does not disclose or describe that the tip of the near-field optical probe is formed of a transparent material having a higher refractive index than that of the transparent material of the cantilever to increase an amount of near-field light generated or detected by the microscopic aperture, as required by amended independent claim 1 from which claim 8 depends.

In view of the foregoing, applicants respectfully request that the rejection of claim 8 under 35 U.S.C. §103(a) as being unpatentable over Shimada be withdrawn.

Claim 38 was rejected under 35 U.S.C. §103(a) as being unpatentable over Gemma in view of Shimada. Applicants respectfully traverse this rejection and submit that the combined teachings of Gemma and Shimada do not disclose or suggest the subject matter recited in claim 38.

The primary reference to Gemma does not disclose or suggest the subject matter recited in independent claim 12 as set forth above for the rejection of claims 12-14 and 37 under 35 U.S.C. §102(b) as being anticipated by Gemma. Claim 38 depends on and contains all of the limitations of independent claim 12 and, therefore, distinguishes from Gemma at least in the same manner as claim 12.

The secondary reference to Shimada was cited by the Examiner for its disclosure of a probe having a pyramidal-shaped tip. However, Shimada does not disclose or suggest the structural combination of the near-field optical probe recited in independent claim 12, including the condition that when a radius of a light spot on the cantilever resulting from light incident on the tip or light detected by the microscopic aperture and being incident on a detector is R_1 , a distance L_1 from a center of the tip to a free end of the cantilever

satisfies the equation $R1 < L1 < H / \tan \theta 1$. Since Shimada does not disclose or suggest the structure and condition required by independent claim 12, it does not cure the deficiencies of Gemma. Accordingly, one of ordinary skill in the art would not have been led to modify the references to attain the claimed subject matter.

In view of the foregoing, applicants respectfully request that the rejection of claim 38 under 35 U.S.C. §103(a) as being unpatentable over Gemma in view of Shimada be withdrawn.

Claims 12 and 15 were rejected under 35 U.S.C. §103(a) as being unpatentable over Quate '985 in view of Gemma. Applicants respectfully traverse this rejection and submit that the combined teachings of Quate '985 and Gemma do not disclose or suggest the subject matter recited in claims 12 and 15.

The primary reference to Quate '985 discloses a near field optical probe having a cantilever and a tip. As recognized by the Examiner, Quate '985 does not disclose or suggest that the cantilever is disposed at an inclination angle $\theta 1$ relative to a surface of a sample, as recited in independent claim 12. Furthermore, Quate '985 does not disclose or suggest that when a radius of a light spot on the cantilever resulting from light incident on the tip or light

detected by the microscopic aperture and being incident on a detector is R_1 , a distance L_1 from a center of the tip to a free end of the cantilever satisfies the equation $R_1 < L_1 < H/\tan \theta_1$, as recited in independent claim 12.

The Examiner cited the secondary reference to Gemma for its disclosure of inclining a cantilever for near-field probing. However, Gemma does not disclose or suggest the subject matter recited in independent claim 12 as set forth above for the rejection of claims 12-14 and 37 under 35 U.S.C. §102(b) as being anticipated by Gemma. More specifically, like Quate '985, Gemma does not disclose or suggest that when a radius of a light spot on the cantilever resulting from light incident on the tip or light detected by the microscopic aperture and being incident on a detector is R_1 , a distance L_1 from a center of the tip to a free end of the cantilever satisfies the equation $R_1 < L_1 < H/\tan \theta_1$, as required by independent claim 12. Since Gemma does not disclose or suggest this feature required by independent claim 12, it does not cure the deficiencies of Quate '985. Accordingly, one of ordinary skill in the art would not have been led to modify the references to attain the claimed subject matter.

Claim 15 depends on and contain all of the limitations of independent claim 12 and, therefore, distinguishes from the references at least in the same manner as claim 12.

In view of the foregoing, applicants respectfully request that the rejection of claims 12 and 15 under 35 U.S.C. §103(a) as being unpatentable over Quate '985 in view of Gemma be withdrawn.

Claims 12, 16 and 18 were rejected under 35 U.S.C. §103(a) as being unpatentable over Shimada in view of Gemma. Applicants respectfully traverse this rejection and submit that the combined teachings of Shimada and Gemma do not disclose or suggest the subject matter recited in claims 12, 16 and 18.

The primary reference to Shimada discloses a near field optical probe having a cantilever and a tip. As recognized by the Examiner, Shimada does not disclose or suggest that the cantilever is disposed at an inclination angle θ_1 relative to a surface of a sample, as recited in independent claim 12. Furthermore, Shimada does not disclose or suggest that when a radius of a light spot on the cantilever resulting from light incident on the tip or light detected by the microscopic aperture and being incident on a detector is R_1 , a distance L_1 from a center of the tip to a free end of the cantilever satisfies the equation $R_1 < L_1 < H/\tan \theta_1$, as recited in independent claim 12.

The Examiner cited the secondary reference to Gemma for its disclosure of a cantilever for near-field probing.

However, Gemma does not disclose the subject matter recited in independent claim 12 as set forth above for the rejection of claims 12-14 and 37 under 35 U.S.C. §102(b) as being anticipated by Gemma. More specifically, Gemma does not disclose or suggest that when a radius of a light spot on the cantilever resulting from light incident on the tip or light detected by the microscopic aperture and being incident on a detector is R_1 , a distance L_1 from a center of the tip to a free end of the cantilever satisfies the equation $R_1 < L_1 < H/\tan \theta_1$, as required by independent claim 12. Since Gemma does not disclose or suggest this feature required by independent claim 12, it does not cure the deficiencies of Shimada. Accordingly, one of ordinary skill in the art would not have been led to modify the references to attain the claimed subject matter.

Claims 16 and 18 depend on and contain all of the limitations of independent claim 12 and, therefore, distinguish from the references at least in the same manner as claim 12.

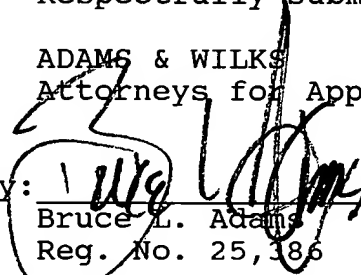
In view of the foregoing, applicants respectfully request that the rejection of claims 12, 16 and 18 under 35 U.S.C. §103(a) as being unpatentable over Shimada in view of Gemma be withdrawn.

The amendment to claim 9 made herein does not raise new issues requiring further search and/or consideration. Instead, claim 9 has been amended to overcome the rejection under 35 U.S.C. §112, first paragraph, by changing "gradient-index lens" to "refractive-index lens" which is supported by the disclosure on page 19, lines 5-10 of the specification, thereby placing the application in condition for allowance or otherwise materially reducing the issues which remain for appeal.

In view of the foregoing amendments and discussion,
the application is believed to be in allowable form.
Accordingly, favorable reconsideration and allowance of the
claims are most respectfully requested.

Respectfully submitted,

ADAMS & WILKS
Attorneys for Applicants

By: 
Bruce L. Adams
Reg. No. 25,386

50 Broadway - 31st Floor
New York, NY 10004
(212) 809-3700

MAILING CERTIFICATE

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Debra Buonincontri

Name

Debra Buonincontri

Signature

December 15, 2003

Date